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Abstract

**COMPATIBILITY PROBLEMS OF CANNING MATERIALS WITH
CARBON DIOXIDE AT HIGH TEMPERATURES**

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The adoption in France of carbon dioxide under pressure as a heat-carrying fluid in "advanced" reactors of the gas-graphite and gas heavy water types has led to the necessity of finding a canning material capable of replacing magnesium alloys. Actually these latter can no longer be used above about 500°C, because of the proximity to their melting points and of their mechanical properties which become under these conditions insufficient, although their oxidation resistance in the presence of carbon dioxide is still acceptable.

Beryllium which is particularly attractive because of its low neutron capture cross-section, has a very big disadvantage, amongst others : its use in the presence of carbon dioxide at 600°C is only possible if the gas is perfectly dry, the water-vapour partial pressure being the determining factor calling for a degree of drying which increases with increasing absolute pressure. In the opposite case, after a short incubation period, the oxidation accelerates and leads to an intergranular corrosion which is rapidly destructive. Nevertheless, beryllium-calcium or beryllium-magnesium alloys containing 0,5 p. 100 of the addition element make it possible to overcome this difficulty ; they may be used in the presence of a few hundred vpm of water vapour up to at least 700°C.

The metallurgical problems connected with the applicability of beryllium or its alloys have led however to the consideration of possibly using provisionally austenitic stainless steels.

These materials are intrinsically very resistant to oxidation, but, as only small thicknesses can be used because of their high capture cross-section, it is necessary to choose the grades which are least prone to oxidation. Above 600°C, the niobium stabilised grades, without addition of molybdenum, are the most acceptable. Above 700°C, the 20 Cr-25 Ni + Nb grade appears more suitable than the conventional 18 Cr - 10 Ni + Nb grade, especially as it is less liable to local oxide penetrations.

Furthermore, iron-aluminium alloy containing 25 p. 100 by weight of aluminium has a remarkable oxidation resistance while at the same time it allows an appreciable saving of neutrons ; its production however is still difficult technologically.

Finally recent research has showed that zirconium based alloys containing 1 to 4 p. 100 of copper by weight could become an acceptable solution up to temperatures of about 600°C. These alloys are in fact oxidised much slower than unalloyed zirconium and other conventional alloys which had previously been eliminated for this reason.

In conclusion, amongst the materials capable of resisting to the physico-chemical conditions to which would be subjected the fuel element cans in "medium temperature" reactors, the most suitable for immediate application would appear to be austenitic stainless steels and zirconium - copper alloys since the metallurgy of both is comparatively well known. In the future the practical advantages of beryllium and iron-aluminium alloys should increase as a result of the research carried out with a view to improving their technological and mechanical properties.